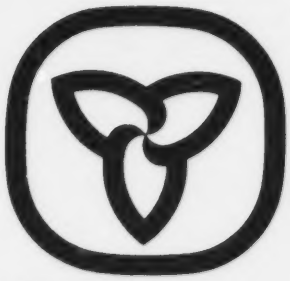

Ontario

Ministry of Energy

Part II

ONTARIO'S ENERGY DEMAND

TO 2000

UPDATE 1983

Ministry of Energy

December 1983

This report is Part II of the Submission by the Ontario Ministry of Energy to the National Energy Board in relation to the Board's Update of Energy Supply and Demand, 1983-2005.

FOREWORD

The Ontario Ministry of Energy produces regular analyses and forecasts of the province's energy requirements. It maintains a set of highly disaggregated models and uses them to prepare long term demand projections for oil, natural gas, coal, electricity and other energy forms. The forecasts incorporate demographic, economic and technology trends as well as energy pricing considerations.

This report deals with the province's energy demand to the year 2000. The study was completed in September 1983.

CONTENTS

		Page
	FOREWORD	
I.	OVERVIEW OF THE ENERGY DEMAND PROJECTIONS	1
	I.1. Introduction	1
	I.2 Demographic, Economic and Energy Price Assumptions	2
	I.3 Summary of the Energy Demand Projections	11
II.	INDUSTRIAL SECTOR	24
	II.1 The Demand Model	24
	II.2 Short Term Results: 1980-1985	25
	II.3 Long Term Projections: 1985-2000	30
	II.4 Key Assumptions	34
III.	COMMERCIAL SECTOR	39
	III.1 The Demand Model	39
	III.2 Short Term Results: 1980-1985	40
	III.3 Long Term Projections: 1985-2000	42
	III.4 Key Assumptions	46
IV.	RESIDENTIAL SECTOR	50
	IV.1 The Demand Model	50
	IV.2 Short Term Results: 1980-1985	50
	IV.3 Long Term Projections: 1985-2000	53
	IV.4 Key Assumptions	56
V.	TRANSPORTATION SECTOR	62
	V.1 The Demand Model	62
	V.2 Short Term Results: 1980-1985	62
	V.3 Long Term Projections: 1985-2000	65
	V.4 Key Assumptions	69
VI.	ENERGY SUPPLY SECTOR	76
	VI.1 Methodology	76
	VI.2 Summary of Results	77
	VI.3 Key Assumptions	80
VII.	APPENDIX ONE: TOTAL ENERGY DEMAND BY SECTOR AND FUEL FOR 1980, 1985, 1990, 1995 AND 2000	

LIST OF TABLES

Table No.	Title	Page
1.1	Secondary Energy Demand by Sector, 1980-85	15
1.2	Secondary Energy Use by Fuel, 1980-85	15
1.3	Summary of Assumptions and Results	20
1.4	Shares of Secondary Energy Requirements by Fuel	21
1.5	Energy Growth Rates	23
1.6	Shares of Primary Energy Requirements by Fuel	23
2.1	Industrial Sector Energy Use, 1980-85	29
2.2	Industrial Sector Energy Demand Growth Rates	33
2.3	Industrial Sector Fuel Shares	33
3.1	Commercial Sector Energy Use, 1980-85	41
3.2	Commercial Sector Fuel Demand Growth Rates	45
3.3	Commercial Sector Fuel Shares	45
4.1	Residential Sector Energy Use, 1980-85	52
4.2	Residential Sector Fuel Demand Growth Rates	55
4.3	Residential Sector Fuel Shares	55
4.4	Different House Types	56
4.5	Residential Sector Energy Demand by End Use	57
4.6	Residential Space Heating - Fuel Market Shares	59
4.7	Residential Water Heating - Fuel Market Shares	60
4.8	Appliance Ownership	61
5.1	Transportation Sector Energy Demand, 1980-85	65
5.2	Transportation Sector Fuel Demand Growth Rates	68
5.3	Transportation Sector Fuel Shares	69
6.1	Growth Rates for Fuels Used for Electricity Generation in Ontario	79
6.2	Fuel Shares for Electricity Generation in Ontario	79

I. OVERVIEW OF THE ENERGY DEMAND PROJECTIONS

I.1 INTRODUCTION

This report presents the Ministry's current projections of energy demand in Ontario to the year 2000. It is assumed that existing government energy policies, particularly those affecting conservation and oil substitution, remain unchanged. The report does not address the appropriateness of existing or future policy directions.

The demand outlook for each type of fuel is analyzed in the industrial, commercial, residential and transportation sectors. It is developed from, and therefore conditional upon, assumptions about demographic, economic and technological trends as well as energy prices.

The next section discusses the major macroeconomic and energy pricing assumptions on which the study is based. Additional assumptions relating to energy-using technologies, composition of the capital stock and the efficiency of energy use are discussed in the subsequent chapters which deal with the situation in each sector.

I.2 DEMOGRAPHIC, ECONOMIC AND ENERGY PRICE ASSUMPTIONS

Demographic Trends

Changes in the demographic composition exert a significant influence upon energy demand. The size and age composition of the population affect the aggregate demand for and supply of goods and services, with particularly important implications for housing and commercial services.

Since 1974 federal immigration policy has tightened considerably. As well, net migration from Ontario to other provinces has increased since the mid-70s. These trends have combined with a long term reduction in fertility rates to produce a deceleration in Ontario's population growth.

Population projections for the province indicate that slow growth will continue well into the future and that the proportion of persons in the mature and senior age brackets will increase steadily. The present analysis of energy demand incorporates these fundamental demographic changes.

- Ontario's population is likely to grow at an average annual rate of 0.8 per cent in the 1980-2000 period. This is well below the average 1.3 per cent rate recorded in the 1970s. The population in 2000 could be in the 10 million range, compared with 8.7 million in 1982.

- The proportion in the 20 - 65 age group would probably rise to 62 per cent in 2000 from 59 per cent at present.

- Persons over 65 years of age would comprise some 14 per cent in 2000, compared with the current level of 11 per cent.

Economic Outlook

The future economic environment was assessed using the DRI macroeconomic model of Canada as well as the macroeconomic and input-output models of the University of Toronto Institute for Policy Analysis. The macro-models provided indicators of economic performance at the national level, and, within that framework, the input-output model generated regional results. The outlook for the provincial economy, including the industrial profile, was thus developed in a national context.

The economic scenario underlying the present energy demand study assumes a further relaxation in domestic monetary policy in the near term but a continuation of fiscal tightness for several more years. It also assumes that the international economy will emerge gradually from the recent severe recession, and, as growth proceeds at a moderate pace over the longer term, problems relating to trade protectionism and financial indebtedness will not become more acute than they are at present. Furthermore, the scenario assumes that world energy markets will not be disrupted by major supply or price shocks.

Key results of the economic assessment are summarized below:

- The Ontario economy is currently in an expansionary phase following a sharp contraction in the 1981-82 period.

- The real Gross Provincial Product (GPP) is projected to grow at an average annual rate of 3.2 per cent in the 1983-85 period. Over the entire current decade, however, growth would average about 2.5 per cent. An improvement to the 2.8 per cent range is expected in the 1990s.

- The trend to a service-oriented economy would continue in response to demographic change and upward shifts in the demand for services. In particular, economic activity in service sectors such as finance, insurance, communications, wholesale and retail trade, and personal and business services will expand faster than the overall economy as a result of specialization and relatively high income elasticities in the long run.

- Growth in the goods-producing industrial sectors, many of which have to compete for export markets, will probably not match the GPP expansion.

- The inflation rate has dropped sharply in 1983 from the double-digit levels of the past two years. The outlook is now more optimistic than was the case a year ago.

- The economic recovery together with an improved inflation prospect has strengthened the long-term outlook for job creation and real income growth.

Energy Prices

The Ministry of Energy produces periodic projections of energy prices. A study completed in mid-1983 covers possible future trends in world oil prices, the Canadian blended price and the wholesale price for natural gas. It also includes retail prices of petroleum products, natural gas and electricity in Ontario.

Energy agreements between the federal government and governments of producing provinces, drawn up in 1981 and subsequently modified, form the basis for domestic crude oil and natural gas prices to the end of 1986. Accordingly, Canadian oil prices are limited by the world oil price, adjusted for quality. As well, the wholesale price of natural gas is fixed at 65 per cent of the Toronto refinery acquisition cost of oil, based on heat content.

The June 30, 1983 Amendment to the Canada-Alberta agreement will keep wellhead oil prices fixed until the end of 1984 if world oil prices remain stable. Canadian oil discovered between 1974 and 1981, which previously qualified under the Special Old Oil Price (SOOP) program, and oil produced through infill drilling receive the New Oil

Reference Price (NORP) effective July 1, 1983. Currently, SOOP oil accounts for approximately 11 per cent of domestic oil production. The reclassification of SOOP oil to NORP oil has increased the potential influence of world oil prices on domestic energy prices.

Since 1980, the gap between the average domestic oil price and the world oil price has narrowed considerably as a result of sharp increases in Canadian wellhead prices and a decline in the world price. Currently, the Toronto refinery acquisition cost is just over 90 per cent of the average cost of imported oil landed in Montreal, adjusted for quality.

It is recognized that the world oil market is quite unstable at present and it is likely to remain so for quite some time. There is a large amount of shut-in capacity, mainly within the Organization of Petroleum Exporting Countries (OPEC) and in Mexico. Despite OPEC's relative success in restraining production within its membership, the "cartel" is now weaker than was the case only a few years ago. As long as excess capacity is significant, OPEC, like any other cartel, will have difficulty in maintaining

control over price or production within the group. This situation raises the possibility of a decline in real oil prices, especially in the near term.

Another source of market instability, at least in the short run, is fluctuation in demand. The world economy is currently emerging from the recent severe recession, with the United States and Japan leading the other members of the Organization for Economic Co-operation and Development (OECD). Should there be a pause in the recovery, the demand for oil could drop, thus increasing the probability of a decline in real prices in the near term.

A third source of instability - short term as well as long term - is the political environment in some major oil-exporting regions. This factor could lead to oil supply disruptions, and depending on the severity of the problem, there could be sudden and sharp price increases.

While many scenarios for world oil prices are possible, the present energy demand analysis is based on one which assumes that no major disruptions will occur in world oil markets, and that economic growth in Western Europe will soon

phase in with the expansion in North America and Japan. Although the rate of international economic growth would probably be moderate by historical standards, a concurrent expansion would lead to increased demand for OPEC oil and a steady reduction in shut-in capacity. The downward pressure on prices which currently exists would ease gradually, and opposite pressures could emerge before the end of this decade. However, actual prices would likely fluctuate rather than ratchet upward steadily over the next few years.

This scenario yields the following prospects for energy prices:

- World oil prices in real terms would decline further in 1984, and, after 2-3 years of relative stability, acquire momentum for escalation at a later stage.

- For purposes of this analysis, it is assumed that demand pressures will be sufficiently strong by the turn of the decade to produce an increase in real prices averaging 5-6 per cent per annum between 1988 and 1993. A moderate advance of about 3 per cent per year is assumed to occur from 1993 to 2000. The

resulting trend in the real price of international oil would reach the 1981 peak in 1994.

- However, the precise timing of world oil price increases is quite uncertain. There is a good likelihood that continuing excess production capacity will limit price escalation until the middle of the 1990s.

- Between 1983 and 1985, retail prices for petroleum products and natural gas in Ontario are unlikely to rise faster than the inflation rate. Beyond 1985, and particularly in the 1990s, prices for these fuels could grow in real terms.

- In the medium term, electricity price increases would likely exceed the inflation rate. However, over the full period from 1983 to 2000, the increase in real terms would probably be quite small.

I.3 SUMMARY OF THE ENERGY DEMAND PROJECTIONS

The projections were developed with the aid of the Ministry's energy demand models for the industrial, commercial, residential and transportation sectors. The models require information from economic and energy price projections as well as detailed assumptions regarding the degree of inter-fuel substitution, conversion efficiencies and changes in the stock of energy-using equipment. Each model aggregates, by end use and fuel types, the estimates of secondary energy requirements. These results, together with assumptions about fuels used in the energy supply sector, form the basis for estimating the demand for primary energy.

The macroeconomic and energy price projections were described earlier. The microeconomic and technical assumptions relating to inter-fuel substitution and end-use efficiency in each sector will be dealt with in subsequent chapters.

Energy Demand: 1980-1985

Ontario's secondary energy demand fell by 12 per cent between 1980 and 1982. The decline was particularly large in the industrial sector (19 per cent), transportation (12 per cent), and the residential sector (7 per cent). Energy use in commercial services such as trade, finance, insurance and business services was virtually unchanged.

This pattern of decline indicates a strong link with the uneveness of the recession across the economy. Industrial output in manufacturing, especially in large energy-using industries such as iron and steel, mining and smelting, and pulp and paper contracted far more sharply than the overall economy. While the real gross provincial product fell by about 5 per cent in 1982, real output in major energy-using industries declined by 12-20 per cent. Freight transportation also contracted much more than the total economy. However, the non-transportation service sectors were only marginally affected in terms of real output.

The 1980-82 reduction in energy demand was due not only to the nature and severity of the recession but also to domestic energy price increases and government conservation programs. Crude oil and natural gas prices rose by 130 per cent and 87 per cent respectively from 1979 to 1982. These increases helped to restrain energy demand in at least two important ways. They had direct impacts on the use of these fuels. They also contributed to the recession and inflation, and led to a pervasive reduction in energy use as a result of the decline in real income and production.

Retail energy prices have risen enormously in real terms over the past decade. Between 1973 and 1982, the general level of consumer prices advanced by 130 per cent. However, price increases amounted to about 250 per cent for gasoline, more than 400 per cent for home heating oil, between 330 and 550 per cent for natural gas in various sectors, and just under 180 per cent for electricity. A major part of these shifts in relative fuel prices has only recently occurred.

The demands for energy fuels and forms in the 1980-82 period have responded in varying degrees

to the combination of recession, relative price changes, conservation and off-oil policy measures. Consumption of oil fell by 19 per cent, coal 15 per cent, natural gas 10 per cent and electricity less than 2 per cent. A major factor was the variation in recessionary impacts within sectors. Many industries, for example, non-metallic minerals and industrial chemicals, whose production declined substantially, are heavy users of oil, natural gas and coal. Also, the off-oil policy and relative price changes have been producing notable differential impacts on fuels used in the residential sector. As well, relative price changes have led to fuel substitution in industrial enterprises which are equipped with dual-firing capability. However, it is unclear that substitution effects in other sectors have been significant in the 1980-82 period. The investment required to reflect fuel choice appropriate to the new structure of relative prices has no doubt been limited by high interest rates.

Table 1.1 Secondary Energy Demand By Sector, 1980-85

(Petajoules)

	1980	1981	1982	1983	1984	1985
Industrial	899	827	732	779	813	835
Commercial	285	284	280	283*	287	290
Residential	485	456	453	465*	470	474
Transportation	626	604	554	570	565	557
Total Secondary	2295	2171	2019	2097	2135	2156

* Adjusted for the effect of the unusually mild winter on space heating requirements.

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 1.2 Secondary Energy Use By Fuel, 1980-85

(Petajoules)

	1980	1981	1982	1983	1984	1985
Oil	973	895	788	810*	800	783
Natural Gas	705	672	637	667*	690	706
Electricity	351	357	346	358*	368	377
Coal	209	187	177	188	200	207
Other**	57	60	71	74	77	83
Total	2295	2171	2019	2097	2135	2156

* Adjusted for the effect of the unusually mild winter on space heating requirements.

** Includes wood, wood waste, spent pulping liquor, propane, solar and other renewables.

Sources: Statistics Canada and Ontario Ministry of Energy.

With the resumption of economic growth in 1983, energy demand, adjusted for weather, is expected to rise once again, mainly in the industrial sector. However, past price increases and conservation programs will continue to restrain energy use throughout the economy. Furthermore, the economic recovery itself is expected to be moderate by historical standards.

- The level of total energy demand in 1985 is likely to be as much as 6 per cent below the 1980 level.

- In particular, most of the reduction in oil demand over the past few years will probably be permanent. By 1985, oil consumption might be some 20 per cent below the 1980 level. It would take an enormous amount of economic growth or a massive reduction in the real price of oil products to restore demand in the near term.

Energy Demand: 1985-2000

Beyond 1985, Ontario's secondary energy demand will increase but at rates substantially below those recorded in the 1970s. Energy price

effects, improvements in the efficiency of energy use, and the pace and character of economic growth all contribute to this expected long term trend.

The process of adjustment to past energy price increases is long and complex. It involves changes in the behaviour of energy users, conversion of equipment to use relatively cheaper energy forms, adoption of existing energy-saving technology and development of new and more efficient technologies. Normally the least expensive responses can be expected to occur before those which are more costly. Furthermore, those adjustments which require large investments, for example, turnover and improvements in the stock of energy-using equipment and structures, tend to be delayed by weakness in the economy and high interest rates. Consequently, the own-price and cross-price elasticities of fuel demands are likely to be smaller in the short run than in the long term. Furthermore, the <u>incremental</u> impact can be expected to diminish as the stock of older, inefficient capital goods becomes progressively smaller.

Data from the Canadian Industry Program for Energy Conservation indicate a marked improvement (about 15 per cent) in the efficiency of energy use in industries since the mid-70s. While further gains are likely in the years ahead, the rate of improvement is assumed to diminish beyond the mid-80s.

Efficiency gains have also been secured in the residential, commercial and transportation sectors. Based on the available data, it appears that improvements to date have not been as large as those in goods-producing industries. The projections of energy demand in the non-industrial sectors incorporate a continuation of efficiency gains well into the next decade.

In broad terms, the results in the post-1985 period reflect an extended period of adjustment to energy price increases, mainly those which have already occurred, and continuing improvements in the efficiency of use throughout the economy.

Also, the projections include long-term, fuel-substitution effects. The competitiveness of electricity has improved substantially as a result

of earlier price changes. While it will probably be undermined somewhat in the medium term, it is expected that the position in the 1990s will be more favourable than that which currently exists. In addition, the continuation of off-oil policies will benefit electricity as well as natural gas and renewable energy forms.

The rate of economic expansion and structural change will exert a major influence on the long-term energy demand outlook. As pointed out earlier, the Ontario economy is expected to obtain relatively stronger growth impetus from the service sectors than from the industrial goods-producing sectors. Service industries are generally less energy-intensive than those in the industrial sector. Consequently, in the long run, economic growth in Ontario will likely be secured with relatively small increases in total energy use.

The most significant features of the projections for secondary energy demand in the province are set out below:

- Over the full 1980-2000 period, growth in total energy demand would likely average less than one per cent per year, based on real GPP growth of 2.7 per cent.

- Following the recession and economic recovery in the 1980 to 1985 period, energy demand is projected to grow at a 1.4 per cent average annual rate. This is about one-half the growth rate for the economy. It contrasts sharply with the experience of the 1970s when energy use grew at about three-quarters of the rate for the economy.

Table 1.3 - Summary of Assumptions and Results

(% per annum)

	1970/80	1980/90	1990/2000	1980/2000
Population	1.3	1.0	0.7	0.8
Real GPP	3.3	2.5	2.8	2.7
Total secondary energy	2.5	0.2	1.3	0.8
Total primary energy	3.1	0.5	1.6	1.0

Sources: Statistics Canada and Ontario Ministry of Energy.

- The oil share of secondary energy is expected to fall significantly because of its price disadvantage and government off-oil policies.

- Natural gas, a major competitor for oil markets, is likely to improve its position in this decade. However, its share may stabilize between 1990 and 2000 because of competition from coal in the industrial sector and from electricity in the residential sector.

- The electricity share of secondary energy is projected to rise steadily, reaching 18 per cent by 1990 and 20 per cent by 2000. This trend reflects continuing adjustments to the improved long run competitiveness of electricity.

Table 1.4 - Shares of Secondary Energy Requirements by Fuel (% of Total)

	1975	1980	1985	1990	1995	2000
Oil	46	42	36	32	30	28
Natural Gas	30	31	33	35	34	34
Coal	10	9	10	11	11	12
Electricity	14	15	17	18	19	20
Other*	0	3	4	4	6	6

* Includes wood, wastes and solar.

Sources: Statistics Canada and Ontario Ministry of Energy.

- Coal will retain an important part of the total energy market, mainly because of industrial uses.

- Other energy forms include wood waste and spent pulping liquor used in the pulp and paper industry, wood used for home heating, energy from wastes and solar energy. These renewable and recoverable energy forms have a relatively small market at present. However, future expansion in demand will likely occur as a result of emerging technologies for converting wood and wastes to energy and for solar heating.

Total primary energy demand includes secondary energy and energy used in the energy supply industry. It is projected to rise at an annual average rate of approximately 1.0 per cent between 1980 and 2000. This reflects the basic trends in secondary energy use as well as shifts to nuclear generation of electric power.

In summary, the scenario on which the projections are based implies that the demands for energy fuels will grow very slowly in future years. Furthermore, oil will be replaced to a significant degree by electricity and natural gas in non-transportation uses of energy.

Table 1.5 - Energy Growth Rates

(% per annum)

	1970/80	1980/90	1990/2000	1980/2000
Electricity (Secondary)	4.4	1.8	2.4	2.1
Coal (Primary)	0.0	-1.9	2.8	0.4
Oil (Primary)	2.0	-2.3	0.4	-0.9
Natural Gas (Primary)	4.7	1.4	1.1	1.2
Total primary energy	3.1	0.5	1.6	1.0

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 1.6 - Shares of Primary Energy Requirements by Fuel

(% of Total)

	1975	1980	1985	1990	1995	2000
Oil	42	38	32	29	27	26
Natural Gas	25	22	23	24	23	23
Coal	15	14	13	11	12	13
Nuclear	4	12	16	21	22	23
Hydraulic	14	12	13	12	12	11
Other*	0	2	3	3	4	4

* Includes wood, wastes and solar.

Sources: Statistics Canada and Ontario Ministry of Energy.

II. INDUSTRIAL SECTOR

II.1 THE DEMAND MODEL

Industrial energy demand covers energy use in mining, agriculture, forestry, construction and manufacturing. The manufacturing sector is modeled in detail for twelve sub-sectors. Currently, about two-thirds of total use in industry is for process heat and the remainder for motive power, feedstock and auxiliary purposes.

The three leading energy-using industries in Ontario are pulp and paper, iron and steel and industrial chemicals. These three accounted for over half of the industrial sector's total energy requirements in 1982. This calculation includes coal used by the iron and steel industry to produce coke and manufactured gases, and natural gas used as a chemical feedstock.

The projections of energy demand are based on an end-use demand model which incorporates assumptions about growth in industrial output and changes in industrial processes, fuel mix and energy efficiency for new and existing capacity.

Sectoral economic growth projections and assumptions about energy use are presented in section II.4.

II.2 SHORT TERM RESULTS: 1980-1985

In 1980, the industrial sector in Ontario consumed 899 petajoules (PJ) or 39 per cent of secondary energy. By 1982, consumption had fallen to 732 PJ and is expected to recover to 835 PJ by 1985.

Industrial energy consumption in the 1980-85 period reflects the effects of the 1981-82 recession, relative price changes, and conservation and oil substitution investments made since the mid-70s.

Energy use in 1982 was 19 per cent below the 1980 level. This was due in large part to the contraction in industrial output. Some of the largest energy-using industries had major reductions in shipments. Iron and steel production was down 20 per cent from 1981 levels, while mining and non-metallic minerals output fell even further.

The 1980-82 reductions in demand for oil (37 per cent), natural gas (22 per cent) and coal (15 per cent) were substantially greater than for electricity (8 per cent). This was due in part to the impact of the recession on industries such as non-metallic minerals and industrial chemicals that rely heavily on the use of fossil fuels. It was also due to relatively sharper price escalation for oil and natural gas over the past decade, especially since 1980, and government off-oil policies. Furthermore, the pulp and paper industry has increased its reliance on renewable energy sources. In 1980, wood waste and spent pulping liquor accounted for 47 PJ or 38 per cent of energy used by this industry in Ontario. By 1982, the amount derived from these sources had risen to 59 PJ or 45 per cent of the industry's requirement.

The initial energy conservation goals of the Canadian Industry Program for Energy Conservation (CIPEC), typically 10-15 per cent savings per unit output compared to base year use by 1980, were generally achieved. The base year for each sector depends on the year in which a sectoral CIPEC Task Force was formed and on data availability. Most

of the large energy-using industries have 1972-75 base years. Overall industrial sector savings amounted to 15.4 per cent by 1980 versus a weighted goal of 12 per cent.

Further progress was achieved in 1981 resulting in a weighted cumulative saving of 16.3 per cent. However, reduced capacity utilization and investment during the recession reduced the efficiency factor in 1982. The overall weighted savings declined to the 1980 level of 15.4 per cent.

The iron and steel industry's 1980 target was a 3.3 per cent cut in energy use per unit of output. An actual 4.7 per cent reduction was achieved. However, the 1982 recession reversed more than one-half of these efficiency gains.

The task force goal was to achieve a 17.0 per cent fuel efficiency improvement by 1980 in the industrial chemicals sector. A 22 per cent gain was in fact achieved by 1982.

In 1982, the pulp and paper industry was third in energy consumption among industries in Ontario, behind iron and steel and industrial chemicals.

This industry's conservation task force set a goal of reducing 1980 energy consumption per unit of output by 12.0 per cent compared to 1972 levels. The industry has surpassed this target and has now adopted a 1985 goal of 30 per cent reduction relative to 1972. Progress by 1982 was 17.0 per cent.

With the resumption of industrial growth, energy demand is expected to increase from 1982 to 1985. The increase for natural gas could amount to 15 per cent, oil 19 per cent, coal 17 per cent and electricity 10 per cent. This pattern essentially reflects the general restoration of growth in production and the specific recovery of those industries which use large amounts of fossil fuels.

However, energy demand is unlikely to return to 1980 levels in the near term. There are several reasons for this. First, while general manufacturing activity will have recovered, excess capacity will persist in some energy intensive industries such as mining and non-metallic minerals. Second, as capacity utilization rates improve in most industries, the efficiency of energy use will also rise. Third, lower interest

rates and the restoration of cash flow will enable companies to undertake some of the conservation investments which were postponed during the recession. Finally, there will be the continuing impact of earlier energy price increases. As a result, oil and natural gas use will be some 25 per cent and 11 per cent below their respective 1980 levels.

Table 2.1 - Industrial Sector Energy Use, 1980-85

(Petajoules)

	1980	1981	1982	1983	1984	1985
Oil	153	137	96	109	113	114
Gas	355	317	276	295	308	317
Electricity	135	136	124	127	132	137
Coal	209	187	177	188	200	207
Other*	47	50	59	60	60	60
Total	899	827	732	779	813	835

* Includes wood wastes and spent pulping liquor.

Note: Industrial demand includes energy use in mining, manufacturing, agriculture, forestry and construction. Actual data for 1980-82 and projections for 1983-85.

Sources: Statistics Canada and Ontario Ministry of Energy.

II.3 LONG TERM PROJECTIONS: 1985-2000

In 1985, the industrial sector is expected to use 835 PJ or 39 per cent of Ontario's total secondary energy demand. In 2000, energy requirements for the sector are projected to be 1235 PJ, or 46 per cent of the total. Over the 1980-2000 period, total industrial energy demand could grow at a 1.6 per cent average annual rate. For the 1985-2000 period, industrial energy demand is expected to grow at 2.6 per cent per annum.

The attainment of CIPEC targets will help keep industrial energy demand growth at a rate which is below that of industrial output in the near term. Beyond 1985, there will be a continuing response to earlier energy price escalation. Major equipment such as furnace and boiler systems with an economic life of 10-20 years, will have to be replaced in this time period. New, efficient, 'state of the art' systems will be introduced as replacement of existing systems is required, as changes in production processes occur, and as new production capacity is needed.

These technological efficiency gains will help to restrain the growth in energy demand relative to

the expected 3 per cent growth in industrial output in the 1985-2000 period.

Perhaps the most significant feature of the industrial energy demand outlook is the trend away from oil, mainly toward electricity. The competitiveness of electricity has improved substantially as a result of large relative increases in oil and gas prices over the past decade. Recent trends in fuel shares in some energy intensive industries are already reflecting relative price effects. For example, oil is being replaced by natural gas in the lime industry, and by electricity and natural gas in pulp and paper, and mining and smelting. Also, electricity has been gaining from both natural gas and oil in iron and steel production. In view of the long lead times for investment, the shift to electricity could continue for several more years.

Natural gas has been benefiting from the off-oil shift. Existing federal government policy supports the installation of natural gas firing capability, thus making it possible for natural gas to expand into the industrial fuel oil market. However, past price increases for natural gas have exposed this fuel to competition from

wood waste in the pulp and paper industry and from electricity and coal in other industries. In the years ahead, a significant reduction in the relative price of natural gas might be required if this fuel is to have a growing market share.

A major shift to coal from oil and natural gas has already occurred in the cement industry. However, future coal requirements will grow primarily in response to coking needs in iron and steel production, where it is used as both an energy source and a raw material. In the second half of the 1990s some of this coke could be replaced by electricity if the plasma arc process is adopted.

Electricity could, over the 1980-2000 period, record an average growth of 2.2 per cent per year. For the post-1985 period, average annual growth could be in the range of 2.9 per cent. This is somewhat higher than the projected growth rate for natural gas.

Renewable energy use, primarily in the pulp and paper industry, will continue to expand, thereby reducing the growth in demand for conventional energy.

Table 2.2 - Industrial Sector Energy Demand Growth Rates

(% per annum)

	1970/80	1980/90	1990/2000	1980/2000
Oil	-1.0	-1.6	1.1	-0.3
Natural Gas	4.3	1.4	1.8	1.6
Coal	-0.3	1.8	2.2	2.0
Electricity	2.8	1.4	3.1	2.2
Other*	-	3.5	2.1	2.8
Total	2.2	1.2	2.0	1.6

* Includes wood waste, spent pulping liquor, solar and other renewables.

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 2.3 - Industrial Sector Fuel Shares

(% of Total)

	1975	1980	1985	1990	1995	2000
Oil	22	17	14	13	12	12
Natural Gas	40	40	38	40	40	40
Coal	24	23	25	25	25	25
Electricity	14	15	16	15	16	17
Other *	N/A	5	7	7	7	6

* Includes wood waste, spent pulping liquor, solar and other renewables.

Sources: Statistics Canada and Ontario Ministry of Energy.

II.4 KEY ASSUMPTIONS

For the purpose of estimating future growth in energy demand in the industrial sector, the macroeconomic projections were combined with specific assumptions about energy conservation and fuel substitution. The main assumptions for the industrial sector as a whole are set out below, along with assumptions about major sub-sectors.

Economic Growth: Real domestic product for manufacturing is projected to increase at a rate of 1.8 per cent in the current decade and 2.8 per cent in the 1990s. For 1982-2000, growth is projected to be 3.1 per cent per annum.

Conservation: Conservation measures will be adopted where the return on investment and payback period are attractive compared to alternative investments. Recent industry experience has shown that conservation investments have often had higher than expected paybacks and have been essentially risk-free. However, in view of the current projections for energy prices, the return on conservation investment may be revised downward.

The weighted efficiency target set by CIPEC is a further 7.6 per cent energy saving. This would amount to an overall reduction in energy use per unit output of 23 per cent in 1985 compared to base year levels.

Between 1985 and 2000 additional savings of 5-10 per cent are assumed for fossil fuel use. New industrial plants are assumed to have fossil fuel requirements that are 15-25 per cent below those of existing plants of equivalent size.

Cogeneration: Cogeneration is currently significant in Ontario in the pulp and paper industry and to a lesser extent in the primary metals and chemicals industries. The economic potential for additional industrial cogeneration in Ontario before the year 2000 is projected to be in the 500-1000 MW range, about 2-4 per cent of Ontario Hydro's existing capacity. Currently, 600 MW of industrial self-generation capacity exist in Ontario.

The electricity produced and used by industry is counted as industrial sector demand while the primary fuels used to generate the electricity are counted in the energy supply sector.

Fuel Choice: The assumptions made about fuel choice in each industry are based on estimates of the stock of energy-using equipment and projections of relative fuel prices. These are outlined below for large energy-using industries.

Pulp and Paper: For newsprint, fine paper and other products, the forecast average growth rate is 2.1 per cent for the 1980s and 3.4 per cent for the 1990s.

The main assumption made with regard to process choice is that thermo-mechanical pulping (TMP) will continue to replace chemical pulping because of its higher yield and reduced environmental pollution. The TMP process consumes more electricity but less fossil fuel than chemical processes.

Iron and Steel: Output in this industry is projected to grow at an average annual rate of 1.9 per cent during the 1980s and 2.2 per cent in the 1990s.

The industry's conservation Task Force has set a 1985 target of a 7 per cent efficiency gain relative to 1972. It is assumed that this will be achieved.

Open hearth furnaces, accounting for 23 per cent of capacity in 1976, will likely be replaced before 2000. New replacement capacity is expected to be 90 per cent basic oxygen furnaces and 10 per cent electric. Basic oxygen furnaces use significantly less energy than open hearth furnaces.

Coke oven and blast furnace gas used for the generation of electricity is assumed to grow at the same rate as coking coal. In the mid - 1990s some electricity substitution in the form of plasma arc technology may be introduced to reduce coking coal consumption.

Industrial Chemicals: The industrial chemicals industry uses natural gas and oil as both a fuel source and a feedstock. The Ministry's industrial energy demand model counts natural gas used as feedstock in the industrial sector. However, oil used as a feedstock is counted in the petrochemical sub-sector of the energy supply sector.

Ontario ethylene production has fallen significantly since 1980. Some growth from this low level is expected after 1982. Chlorine output will likely be constant until 1986, after which it could grow at a rate of 2.4 per cent annually. Ammonia output is expected to increase by 50 per cent in 1985. No increase is projected thereafter.

It is assumed that all new chlorine capacity will use energy-efficient membrane cells instead of diaphragm cells, and that between 1985 and 1995 all existing capacity will switch to membrane cells.

Based on energy efficiency gains to date, the CIPEC sectoral target of 31 per cent to 1985 is assumed to be achieved. However, incremental improvements in energy use are likely to be limited by rising costs.

III. COMMERCIAL SECTOR

III.1 THE DEMAND MODEL

Commercial sector energy demand covers energy use in institutional buildings (for example, schools, universities and colleges, hospitals and nursing homes) as well as in commercial buildings (for example, offices, retail stores, hotels, theatres and warehouses). Municipal waterworks and street lighting are also part of this sector. Currently, about 65 per cent of the sector's total energy use is for space heating and cooling, and the rest is for water heating, lighting and auxiliary purposes.

An end-use demand model is used to project energy requirements. It incorporates assumptions regarding the stock of different buildings, energy efficiency factors for each end-use in existing and in new buildings, and future fuel shares for space heating and water-heating loads. Key assumptions are outlined in section III.4.

III.2 SHORT TERM RESULTS: 1980 - 1985

Energy demand in the commercial sector amounted to 285 PJ or 13 per cent of total secondary energy in 1980. It is expected to change only marginally by 1985.

Total energy use fell slightly in 1982. Energy management programs, introduced in government buildings since 1980, have contributed to this result. Also, milder than normal weather reduced space-conditioning needs in the entire sector. Large oil and natural gas price increases were an additional factor. However, the direct effect was perhaps limited because institutional arrangements which generally include energy costs in rents tend to interfere with the transmission of price signals to tenants.

During the recession, real output in the services sector declined, but only by about 0.5 per cent. The recession very likely led to underutilization of floor space in the private sector. However, the main applications (heating and cooling) are relatively insensitive to occupancy rates in many types of building structures.

As the economic recovery proceeds, increases in service sector output will initially come from more intensive utilization of existing buildings. Therefore, it is unlikely that energy demand growth would match the 2.3 per cent average growth in output over the 1980-85 period. In 1985, this efficiency gain together with conservation measures will reduce energy use per square metre in existing buildings by 6.5 per cent from the 1980 levels.

Table 3.1 - Commercial Sector Energy Use, 1980-85

(Petajoules)

	1980	1981	1982	1983**	1984	1985
Oil	47	43	40	40	38	36
Natural Gas	141	141	140	141	145	148
Electricity	97	100	100	102	104	106
Total*	285	284	280	283	287	290

* Includes solar energy use which amounts to 0.1 PJ in 1982, rising to 0.2 PJ in 1985.

** Because of the unusually mild winter, actual results could be as much as 7 per cent below those shown.

Note: Actual data for 1980, and projections for 1981-1985. The estimates for 1981 and 1982 differ from Statistics Canada data due to a reclassification of one major enterprise from industrial to commercial.

Sources: Statistics Canada and Ontario Ministry of Energy.

Although the total amount of energy used is likely to grow modestly in the near term, changes in fuel shares will be significant.

Oil consumption has already declined by 15 per cent between 1980 and 1982. A further 10 per cent reduction is projected in the next three years. Natural gas and electricity will remain the prime substitutes for oil.

In 1980, oil met 16 per cent of commercial sector energy demand. Natural gas provided about 49 per cent and electricity 35 per cent. By 1985, the market share for oil would decline to 12 per cent while natural gas and electricity shares would increase slightly.

III.3 LONG TERM PROJECTIONS: 1985-2000

By the year 2000, energy use in the commercial sector is projected to be about 347 PJ, or 13 per cent of the provincial total. The increase from the 1985 level of 290 PJ represents an annual growth rate of approximately 1.2 per cent.

Service sector activity is expected to grow at a faster pace than the overall economy, with real output expanding at a 3.6 per cent average rate. This reflects an increasing demand for services such as communications, business and finance, hotel accommodation, restaurant meals, recreation, care for senior citizens and warehousing. Much of this growth is likely to arise from technology-based productivity gains. Therefore, output growth may occur without equivalent changes in floor space. Total floor space is expected to grow by 2.1 per cent per year.

Additional floor space will form the basis for an increase in energy demand. However, given the large rise in energy costs to date, new buildings are likely to be much more efficiently designed in the years ahead. Also, ageing of the existing stock will create a continuing need for renovations. Since retrofit is more economical when undertaken as part of the renewal process, the average efficiency of energy use is likely to increase in the long run. Consequently, energy demand is expected to grow more slowly than floor space. Furthermore, the energy requirement for space heating will likely decline in relation to total energy use (from 58 per cent in 1980 to about 52 per cent by the turn of the century).

Due to relative fuel costs, a persistent movement from oil-based heating systems is anticipated, primarily to natural gas in the current decade and electricity in the 1990s. These trends will be evident in both existing and new buildings. There may also be some increase in the use of energy from waste and wider application of solar heating technology as cost-effectiveness improves.

Electricity is required not only for heating, but also for cooling, lighting and auxiliary purposes. These uses, which amounted to 38 per cent of total energy use in 1980, could grow to some 44 per cent by the year 2000. All uses considered, a notable improvement in the market position for electricity is expected over the long term.

Table 3.2 - Commercial Sector Fuel Demand Growth Rates

(% per annum)

	1970/80*	1980/90	1990/2000	1980/2000
Oil	-9.3	-5.6	-4.2	-4.9
Natural Gas	8.2	1.0	1.1	1.1
Electricity	7.8	1.7	2.8	2.3
Solar & Wastes	0.0	31.1	20.9	25.8
Total	2.3	0.4	1.5	1.0

* Growth rates shown are for the 1970-1977 period which is more representative of the 1970/80 period owing to the break in the series caused by Statistics Canada's revisions in 1978.

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 3.3 - Commercial Sector Fuel Shares

(% of Total)

	1975*	1980	1985	1990	1995	2000
Oil	16.2	16.3	12.4	8.8	6.4	4.9
Natural Gas	50.5	49.1	51.0	52.1	51.7	50.1
Electricity	33.3	34.6	36.5	39.0	41.6	44.4
Solar & Wastes	0.0	0.0	0.1	0.1	0.3	0.6

* Prior to 1978, apartment buildings were included in the commercial sector (rather than residential). Consequently, the 1975 figures overstate the fuel shares for natural gas and electricity while understating the oil share.

Sources: Statistics Canada and Ontario Ministry of Energy.

III.4 KEY ASSUMPTIONS

The macroeconomic and energy pricing forecasts are used to estimate the future amount and composition of commercial sector floor space. These forecasts also influence assumptions about other determinants of energy use such as fuel choice and efficiency.

Building Stock

Total building stock is projected to grow by some 44 per cent in the 1982-2000 period, with the greatest growth in offices, hotels and restaurants and the least in institutional buildings. Specific assumptions are outlined below.

Institutional Buildings: Over the forecast period, health care floor space is likely to expand in response to the needs of the ageing population. However, there may not be any net increase in school floor space.

Offices: Office floor space demand depends upon service sector output levels. However, increased productivity is assumed to restrain the demand for additional floor space in relation to output.

Hotels and Restaurants: The return to positive economic growth is assumed to reduce the current surplus of hotel accommodation over the short-term. Additions to hotel floor space are anticipated as business travel and leisure activity increase with general economic and disposable income growth. In addition, increased disposable income will spur the demand for out-of-home meals and restaurant facilities. Furthermore, these trends will likely become more pronounced with the maturing of the population.

Stores and Warehouses: Floor space expansion in retail trade will arise from the increasing demand for consumer goods. Higher levels of retail and wholesale trade will in turn require more warehousing facilities. However, since manufacturers and merchandise traders are becoming more cognizant of inventory holding costs, it is assumed that warehouse additions will not match increases in long-term retail trade.

Fuel Choice

Oil use in existing buildings is assumed to decline considerably by the year 2000 due to its relative price disadvantage compared to natural gas and electricity. During the 1980s, natural gas is assumed to be the main substitute.

Electricity is assumed to increase its share of the space and water heating market throughout the forecast period. Similar trends are assumed for new buildings, but with provisions for increased solar energy penetration in the 1990s.

Efficiency

Since the late 1970s, some types of commercial buildings such as schools, universities and government buildings, have achieved reductions of up to 25 per cent in energy used per unit of floor space. This decline is primarily attributed to the implementation of energy management programs.

For the rest of the decade, additional savings may be more costly to obtain. The projections assume further savings of 9 per cent for educational buildings and 12 per cent for office buildings by 1990.

New offices and stores, constructed in the mid-1980s and beyond, are assumed to use one-third less energy than the average for existing buildings. New hospitals and warehouses are assumed to use one-quarter less energy than do existing facilities.

IV. RESIDENTIAL SECTOR

IV.1 THE DEMAND MODEL

Residential sector energy demand relates to energy used for household purposes. Currently, about 73 per cent is required for space heating and cooling, and the balance for water heating and appliance use.

Estimates of future requirements are obtained from an end-use demand model by projecting the stock of energy-using equipment and applying unit consumption figures for each major device. The main assumptions on equipment, conversion efficiencies and fuel choice for different types of housing units are outlined in section IV.4.

IV.2 SHORT TERM RESULTS: 1980-1985

In 1980, the residential sector used 485 PJ, about 21 per cent of Ontario's end-use energy. Of this, oil accounted for 31 per cent, natural gas 43 per cent, electricity 24 per cent and other energy forms such as wood about 2 per cent.

Between 1980 and 1982, there was a 7 per cent drop in residential energy use. This decline was due to a combination of circumstances. Among these were the sharp increases in prices of residential heating fuels, government programs designed to reinforce the conservation ethic, more efficient heating systems and relatively mild weather. Furthermore, some consumers probably economized in their use of energy because of severe inflation and unemployment.

In the near term, energy demand in the residential sector is expected to rise slightly. The housing stock continues to expand and the number of new units is increasing as the economy recovers. Also, it is assumed that normal weather will prevail. (The unusually mild winter has significantly depressed 1983 energy requirements for space heating.) However, the continuing impact of earlier price increases and conservation will keep demand levels below the 1980 peak.

Since 1980, there has been a significant shift away from oil towards natural gas, electricity, wood and propane. This shift has resulted from the increased price competitiveness of natural gas and electricity and from government policies and programs. Between late 1980 and early 1983, there

were close to 160,000 conversions under the federal government's Canadian Oil Substitution Program alone. Of these, 95,000 were conversions to natural gas, 35,000 to electricity and 30,000 to wood and propane. The trend away from oil is expected to continue well beyond 1985.

Table 4.1 - Residential Sector Energy Use, 1980-85

(Petajoules)

	1980	1981	1982	1983**	1984	1985
Oil	148	112	100	95	90	86
Natural Gas	209	214	221	231	237	242
Electricity	118	120	121	128	131	133
Other*	10	10	11	11	12	13
Total	485	456	453	465	470	474

* Primarily wood.

** Because of the unusually mild winter, actual results could be as much as 10 per cent below those shown.

Sources: Statistics Canada and Ontario Ministry of Energy.
Actual data for 1980-82 and projections for 1983-85.

IV.3 LONG TERM PROJECTIONS: 1985-2000

By 2000, residential energy demand is forecast to be 453 PJ, or 17 per cent of the province's total requirements. Virtually, no growth is expected from the current level.

This relative stability in the long term is attributable to several factors. The number of new housing units coming on stream will reflect the diminishing rate of population growth. Also, the trend to multiple units will continue. These factors will lead to small increases in energy use. However, they are likely to be offset by efficiency gains from improved building design, upgrading of the existing housing stock, and improvements in the efficiencies of space-heating and water-heating equipment and other appliances.

Oil consumption will continue to decline because of price disadvantages and off-oil policy measures. These factors will stimulate the demand for electricity. In addition, electricity will continue to dominate in the expanding use of appliances. Moreover, it will retain its market for space-cooling - a market which will grow as

real incomes rise. Consequently, electricity use is expected to increase throughout the forecast period.

The natural gas market will expand well into the 1990s mainly as a result of off-oil measures and improved price competitiveness with respect to oil. However, the penetration rate for natural gas will probably diminish as a result of competition from electricity. Furthermore, efficiency gains in space-heating and water-heating systems will reduce the amount of natural gas used per housing unit.

These trends imply that the market shares for natural gas and electricity will grow substantially as oil is replaced in residential applications. Other fuels such as wood and propane will continue to play an important role in specific parts of the province.

Table 4.2 - Residential Sector Fuel Demand Growth Rates

(% per annum)

	1970/80	1980/90	1990/2000	1980/2000
Oil	-1.8	-11.7	-7.9	-9.6
Natural Gas	5.5	2.1	-0.4	0.9
Electricity	6.5	2.1	1.4	1.7
Other*	3.1	3.4	1.3	2.4
Total	2.7	-0.4	-0.3	-0.3

* Includes wood and solar.

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 4.3 - Residential Sector Fuel Shares

(% of Total)

	1970*	1975*	1980	1985	1990	1995	2000
Oil	48	40	31	18	11	8	5
Natural Gas	33	37	43	51	55	55	55
Electricity	17	21	24	28	31	34	37
Other**	2	2	2	3	3	3	3

* Prior to 1978, apartment buildings were included in the commercial sector by Statistics Canada. Consequently, the 1970 and 1975 figures overstate the fuel share of oil, and understate the shares of natural gas and electricity.

** Includes wood and solar.

Sources: Statistics Canada and Ontario Ministry of Energy.

IV.4 KEY ASSUMPTIONS

Residential energy consumption is related to the stock of housing and the efficiency of energy use in various applications. The main assumptions underlying the projections are outlined below.

Housing Stock

The rate of growth in the housing stock has declined sharply since the late 1970s and it is likely to track the long term demographic trend. Between 1982 and 2000, about one million new housing units might be constructed. Allowing for demolitions, the total housing stock could reach 3.9 million units by the year 2000.

Table 4.4 - Different House Types -
(% of Total Housing Stock)

	1980	1990	2000
Single Detached	57	55	53
Semi/Duplex	10	10	10
Row	5	6	7
Apartments	28	29	30

Sources: Statistics Canada and Ontario Ministry of Energy.

An increasing proportion of new units will be row housing and apartments. The relatively lower cost of multiple units and the increasing average age of the population will support the demand for low maintenance housing.

Space Heating

In 1980, 73 per cent of the energy used in the residential sector was for space heating. This percentage is projected to decline to 67 per cent by 1990 and to 63 per cent by 2000.

Table 4.5 - Residential Sector Energy Demand by End Use (% of Total)

	1980	1990	2000
Space Heating	73	67	63
Water Heating	14	17	18
Appliances and Space Cooling	13	16	19

Source: Ontario Ministry of Energy. The 1980 estimates are based on an Ontario Hydro survey.

It is assumed that space-heating efficiency will improve significantly for the following reasons:

- Conservation measures in existing housing units. Thermal upgrading of the existing housing stock (improved insulation, storm windows, caulking, night setback, etc.) are assumed to account for a 20 per cent reduction in per unit heating requirements by 2000.

- Improved design and building practices. These are assumed to result in a 33 per cent decrease in per unit heating requirements for new construction by 2000.

- Increasing furnace efficiencies. By 2000, the average efficiency of oil furnaces is assumed to increase by 6 percentage points through retrofitting and installation of new, high-efficiency furnaces. For natural gas, the corresponding assumption is a 20 percentage point gain. This, in turn, assumes market acceptance of high-efficiency condensing and pulse furnaces and boilers.

- Heat pumps are assumed to be present in about 4.4 per cent of homes by the year 2000. Their high seasonal performance factor accounts for a possible reduction of 4 PJ in

total residential energy demand by that year. Electric resistance heating is assumed to have an end-use efficiency of 100 per cent throughout the forecast period.

- An increased percentage of housing units using electricity for space heating. The higher end-use efficiency of electricity results in decreased demand for secondary energy.

The assumed distribution of housing units using fuel oil, natural gas or electricity for space heating is shown in Table 4.6.

Table 4.6 - Residential Space Heating - Fuel Market Shares (% of Housing Units)

	1980	1990	2000
Fuel Oil	35	12	6
Natural Gas	48	61	63
Electricity	15	23	27
Other*	2	4	4

* Includes wood and solar.

Source: Ontario Ministry of Energy. The 1980 estimates are based on an Ontario Hydro survey.

Water Heating

In 1980, water heating accounted for approximately 14 per cent of the energy used in the residential sector. Water heating requirements are projected to increase steadily because of growth in the population and the housing stock despite improvements in equipment efficiency. The conversion efficiency is assumed to increase by 10 per cent for gas water heaters and 5 per cent for electric water heaters, leading to a net reduction in per unit energy demand for water heating. Per cent fuel shares for water heating are shown in Table 4.7.

Table 4.7 - Residential Water Heating - Fuel Market Shares

(% of Housing Units)

	1980	1990	2000
Fuel Oil	3	0	0
Natural Gas	42	55	54
Electricity	55	43	40
Other*	0	2	6

* Includes wood and solar.

Source: Ontario Ministry of Energy. The 1980 estimates are based on an Ontario Hydro survey.

Appliances

The ownership of certain major appliances is expected to increase during the forecast period. Lighting and appliances are assumed to improve in efficiency by 10 per cent by the year 2000. These applications are projected to account for 19 per cent of residential energy use in 2000, compared with 13 per cent in 1980.

Table 4.8 - Appliance Ownership

(% of Dwelling Units)

	1980	2000
Freezers	54	60
Dishwashers	30	60
Clothes Dryers	53	60
Central Air Conditioning	9	30

Source: Ontario Ministry of Energy. The 1980 estimates are based on an Ontario Hydro survey.

V. TRANSPORTATION SECTOR

V.1 THE DEMAND MODEL

The Ministry's transportation energy demand model separates energy requirements by major activity - passenger transportation, freight transportation and a residual category of other transportation services. Each of these categories is further subdivided by type of service (for example, intercity and urban groupings) and by mode of transportation (for example, automobile, bus, truck, rail, air and marine). The energy demand projections take account of the volume of service, as well as changes in transportation modes and per unit energy consumption. Key assumptions are outlined in section V.4.

V.2 SHORT TERM RESULTS: 1980-1985

Energy used in the transportation sector amounted to 626 PJ or 27 per cent of the provincial total in 1980.

Demand has declined markedly from the peak consumption levels of the late 1970s. Between 1980 and 1982 alone, a 12 per cent reduction has been registered. A combination of macroeconomic influences affecting both the income of consumers and the price of transportation services has brought about this declining trend.

Beginning in 1980, petroleum product prices increased more rapidly than in previous years. Individual consumers responded by decreasing their consumption of transportation services and seeking more efficient modes of transport. For example, in the 1978-82 period, sales of smaller, lighter and more fuel-efficient automobiles increased rapidly. Also, there is limited data that indicate increasing use of ride-sharing and car-pooling during this period.

The response of the freight transportation sector to higher fuel prices is more complex. Efficiency can be achieved in the short-run through driver education programs, scheduling and duty-cycle improvements, improved maintenance and equipment retrofit. Technological advances such as engine and transmission improvements take longer to

implement and depend upon capital stock turnover. The rail and marine freight sectors have less scope for gains in operating efficiency and much slower capital stock turnover than the trucking sector.

The other major impact on transportation energy demand in the early 1980s was the severe recession of 1981-82. The decline in real, per capita disposable income that accompanied the recession decreased the demand for transportation services in both the passenger and freight sectors. Passenger vehicle-kilometres travelled declined sharply in 1982 for all modes of travel - automobile, bus, rail and aircraft. In the freight sector, the relatively severe contraction in manufacturing output resulted in a concomitant decrease in general freight shipments in 1982.

As economic recovery proceeds in the 1983-85 period, the demand for transportation services would expand. However, earlier gasoline price increases will lead to continued improvement in the average efficiency of the automobile stock. While some U.S. automobile manufacturers have indicated that they might not be able to meet

their corporate average fuel efficiency targets for the 1983-85 model years, new cars are already significantly more efficient than those being replaced. This combination of output and price effects should keep total transportation energy demand fairly stable at current levels.

Table 5.1 Transportation Sector Energy Demand, 1980-85

(Petajoules)

	1980	1981	1982	1983	1984	1985
Petroleum Prod.	625.2	603.4	551.6	566.4	558.9	546.6
Electricity	0.7	0.3	1.3	0.6	0.6	0.6
Other*	0.1	0.3	1.3	2.6	5.1	10.0
Total	626.0	604.0	554.2	569.6	564.6	557.2

* Propane.

Note: Actual data for 1980-82 and projections for 1983-85.

Sources: Statistics Canada and Ontario Ministry of Energy.

V.3 LONG TERM PROJECTIONS: 1985-2000

In 1985, energy consumption in the transportation sector is expected to be about 557 PJ. Refined petroleum products will meet 98 per cent of the total, with gasoline still being the predominant fuel.

By 2000, transportation energy demand is forecast to be 635 PJ, representing an average annual growth of less than one per cent beyond 1985. Despite this growth, the sector's share of Ontario's secondary energy requirements will decline from the current level of 27 per cent to 24 per cent by the turn of the century. Refined petroleum products are expected to continue their dominance but with a smaller market share compared to the early 1980s. Gasoline will maintain its position as the major fuel. However, efficiency improvements and significant substitution by alternative and other petroleum fuels could reduce the gasoline market share to less than sixty per cent of the total.

Transportation energy demand is not expected to exhibit positive growth until the late 1980s. There are two reasons for this.

Average efficiency of the total automobile stock will continue to improve rapidly for several more years in this decade, as older, less efficient stock is replaced with more efficient models. However, by the late 1980s, further fuel gains will become more difficult to achieve as the

proportion of inefficient vehicles declines. In addition, improvements in fuel efficiency are subject to economic and technological constraints.

While the pace of efficiency improvements can be expected to diminish over time, the demand for transportation services will increase with economic growth. Eventually, this demand-related increase will exceed the efficiency gain, resulting in positive energy demand growth.

Gasoline demand will decline throughout the forecast period. However, for the reasons previously cited, the rate of decline in the 1990s will be much more moderate than during the 1980s.

Diesel fuel demand is projected to grow at rates greater than the average for all fuels throughout the forecast period. There are two reasons for this. First, there is some fuel switching in the automobile sector. Second, and more important, the growth in freight-transportation service (which is diesel-intensive) is greater than passenger service growth.

The growth rates for the electricity and 'Other' fuel category could be substantial, reflecting the expected shift from petroleum fuels in the long term. However, base year consumption levels are relatively small compared to total energy consumed and the refined petroleum fuels.

Table 5.2 - Transportation Sector Fuel Demand Growth Rates

(% per annum)

	1970/80	1980/90	1990/2000	1980/2000
Gasoline	3.0	-2.4	-0.3	-1.3
Diesel	8.3	2.1	3.2	2.6
Turbo	6.2	-3.4	0.8	-1.3
Aviation Gas	2.2	-2.9	0.9	-1.4
Fuel Oil	3.3	2.0	1.6	1.9
Electricity	-	0.0	17.6	8.1
Other*	-	23.7+	7.2	12.4++
Total	3.7	-1.0	1.1	0.1

* Other includes propane, methanol and compressed natural gas.

\+ 1985-1990.

++ 1985-2000.

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 5.3 - Transportation Sector Fuel Shares

(% of Total)

	1975	1980	1985	1990	1995	2000
Gasoline	78.0	73.5	70.0	64.1	58.8	55.4
Diesel	10.8	14.9	17.5	19.8	21.6	24.1
Turbo	7.4	7.8	6.4	6.3	6.4	6.1
Aviation Gas	0.3	0.4	0.2	0.2	0.2	0.2
Fuel Oil	3.4	3.4	4.0	4.3	4.4	4.5
Electricity	-	0.1	0.1	0.1	0.3	0.5
Other*	0.0	0.0	1.8	5.1	8.3	9.1

* Other includes propane, methanol and compressed natural gas.

Sources: Statistics Canada and Ontario Ministry of Energy.

V.4 KEY ASSUMPTIONS

A number of macroeconomic variables are used to project the level of transportation activity. Per capita disposable income, population growth and composition, industry production indices, and relative fuel prices influence fuel demands in both the passenger and freight sectors. For instance, an increase in the population over age fifteen compared to the total population increases the demand for passenger transportation services and hence for energy.

In addition to macroeconomic variables, assumptions about future efficiency improvements, fuel choice, and modal choice determine energy requirements. Specific assumptions are discussed below.

Fuel Choice

It is highly likely that automobile energy demands will be predominantly satisfied by gasoline throughout the forecast period. Some shifting to diesel engines is expected, raising the proportion of the automobile stock fueled by diesel from the current level of about one per cent to about nine per cent by 2000. This shift would be larger were it not for constraints on the choice of diesel as a substitute for gasoline. These include the lack of diesel on major transportation routes in Ontario, poor performance in cold weather, emission problems and a possible increase in the relative price of this fuel.

Propane is expected to make a growing and significant contribution to transportation energy requirements. Due to government financial and tax incentives and rapid improvements in the supply and distribution network, propane made substantial

advances in the commercial fleet sector in the 1980-83 period. Given the relative price and efficiency advantages of propane over gasoline, it is possible that about 200,000 vehicles could be operating on propane by 2000. The demand for propane could reach 10 PJ or 1.8 per cent of transportation sector demand in 1985, and 32 PJ, or 5.0 per cent, in 2000.

Non-conventional fuels such as methanol and compressed natural gas (CNG) are assumed to make some penetration into the transportation sector by 2000. Initial introduction of methanol in a blend with co-solvents and gasoline is assumed in the late 1980s. Neat methanol is assumed to be phased in gradually in the early 1990s but could gain wider acceptance later in the decade. CNG is assumed to compete with propane and it could supply 1 PJ in 1990, increasing to 3 PJ in 2000. These three forms of alternative fuels are assumed to provide 4.1 per cent of total transportation energy needs in the year 2000 and are concentrated in the urban fleet market.

Passenger Transportation

The growth rate of passenger transportation, measured by vehicle-kilometres travelled, is expected to decline over the 1980-2000 period compared to the 1970-1980 period. This relative decline is attributable to a decrease in population growth, an increase in the real price of gasoline and a lower rate of growth in personal disposable income.

Automobiles are assumed to maintain their dominant position in the passenger sector, accounting for approximately 90 per cent of passenger travel in 2000. Public transit use is expected to increase faster than automobile use, primarily due to relative price changes and increased urbanization.

The automobile stock is assumed to become more efficient as the older cars are replaced by down-sized vehicles in the near term. This process may slow down in the second half of this decade.

However, by 1990, it is assumed that higher oil prices will result in an improvement in new car efficiency of approximately 2.0 per cent annually

for the 1989-1994 period, gradually declining to 1.0 per cent annually in the 1997-2000 period. New car efficiency ratings for intercity travel are projected to increase from 10.3 litres/100 km (27.4 M.P.G.) in 1980 to 6.9 litres/100 km (40.8 M.P.G.) in 2000; fuel efficiency in urban transportation could improve from 15.2 litres/100 km (18.6 M.P.G.) in 1980 to 10.2 litres/100 km (27.7 M.P.G.) in 2000.

No major technological changes that affect fuel efficiency are assumed in the bus, train, transit and marine modes. Air transportation holds the greatest promise for efficiency gains in the form of improved design, use of light-weight materials, higher seating densities and more efficient engine design. However, general economic conditions have severely reduced the airline industry's ability to replace older, less efficient planes with a new generation of fuel efficient planes. Therefore, the possible efficiency gains in the airline sector might not be fully realized.

Freight Transportation

The volume of freight transportation depends upon overall manufacturing activity and the mix of commodities transported. Growth in general freight tonne-kilometres shipped is projected to average 1.7 per cent per year over the 1980-2000 period.

Freight volume also depends upon economic growth in the four major resource groups transported within and across Ontario (iron ore, grain, coal and forest products). Growth in total tonne-kilometres in this specific freight sector could average 1.2 per cent annually over the 1980-2000 period.

Urban freight trucking depends upon general industrial activity and the urban/rural population ratio. Urban freight trucking tonne-kilometres are projected to increase 1.0 per cent annually over the forecast period. Non-freight urban trucking vehicle-kilometres are projected to average 1.6 per cent annually over the same period.

Diesel penetration of the trucking sector is expected to increase. The resulting efficiency gains would moderate the growth in energy demand arising from freight volume increases. In addition, operating improvements are assumed to contribute 0.2 per cent annually to trucking sector efficiency.

Refined petroleum products (gasoline, diesel, heavy fuel oil) are assumed to supply all of the energy requirements in trucking, and almost all in the urban freight sector (where some propane and methanol might be used). No allowance is made for the possible electrification of the Windsor to Cornwall rail corridor. Also, neither marine nor rail is expected to revert to coal use.

VI. ENERGY SUPPLY SECTOR

VI.1 METHODOLOGY

In the Ministry of Energy model, consumption in the energy supply sector includes:

- oil for petrochemical feedstock;
- oil for other non-energy products (eg. asphalt, lubricants and greases);
- oil consumed by petroleum refineries;
- natural gas used by oil refineries, pipelines and gas utilities (petrochemical uses are included in the industrial sector);
- fossil fuels used by utilities and industry to generate electricity;
- energy used to generate steam for the Bruce Heavy Water Plant;
- electricity used by petroleum refineries, pipelines and utilities;

- electrical energy from hydraulic and nuclear sources converted to a primary energy value (10.5 MJ/kWh); and

- losses in transmission of electrical energy.

It excludes net electricity exports and fuels used to generate such exports.

Key assumptions regarding the energy supply sector are dealt with in section VI.6.

VI.2 SUMMARY OF RESULTS

Little growth is expected over the 1980-2000 period in the demand for oil as a petrochemical feedstock or for other non-energy uses in Ontario although a near term recovery is expected from low 1982 levels. By 1990, oil used in refining is expected to fall to 78 per cent of the 1980 amount due to both the extensive conservation measures adopted by the refining industry and the falling demand for oil. By 2000, this number could be 82 per cent of the 1980 level. In the case of natural gas, no significant change is expected in consumption by the energy supply sector.

Electricity use by the energy supply sector is expected to grow at a slow rate (less than 1 per cent per annum) due to a decline in oil refining and pipeline use and reduced transmission losses resulting from the installation of higher efficiency 500 kV transmission lines. Primary energy requirements for electricity generation are forecast to grow at an average annual rate of 2.2 per cent between 1980 and 2000.

Nuclear power demand for electrical generation is expected to grow at a relatively fast rate over the period (4.9 per cent per annum versus 0.4 for hydraulic and a reduction for each of the fossil fuels). Consequently, the nuclear share of provincial generation is expected to increase from 35 per cent in 1980 to 58 per cent by the year 2000.

The share of Ontario primary energy met by indigenous sources is projected to rise to about 37 per cent in 1995.

Table 6.1 - Growth Rates for Fuels Used for Electricity Generation in Ontario (% per annum)

	1970/80	1980/90	1990/2000	1980/2000
Nuclear	42.4	7.0	2.7	4.9
Hydraulic	0.3	0.0	0.8	0.4
Coal	3.3	-6.4	4.5	-0.9
Oil	-13.8	0.0	-11.6	-5.6
Natural Gas	5.7	-4.8	7.2	1.1
Total	5.4	1.9	2.4	2.2

Sources: Statistics Canada and Ontario Ministry of Energy.

Table 6.2 - Fuel Shares for Electricity Generation in Ontario (% of Total)

	1975	1980	1985	1990	1995	2000
Nuclear	15	34	45	56	56	58
Hydraulic	48	39	35	32	30	27
Coal	25	26	19	11	13	14
Oil	1	0	0	0	0	0
Natural Gas	11	1	1	1	1	1

Note: Does not include generation for net exports.

Sources: Statistics Canada and Ontario Ministry of Energy.

VI.3 KEY ASSUMPTIONS

Oil: Petrochemical feedstock use is unlikely to increase significantly in Ontario over the forecast period following a partial recovery from low 1982 levels. The demand for other non-energy products will rise slowly over the period.

In 1982 only about 1 PJ of oil was used to raise steam for the Bruce Heavy Water Plant. No increase is assumed.

Natural Gas: Of the 10 PJ of natural gas used to generate electricity in Ontario in 1982, less than one-tenth was used by Ontario Hydro. The rest was used for industrial generation. While Ontario Hydro's use of natural gas is expected to drop to virtually zero, industrial generation will continue to grow.

Electricity: Transmission and distribution losses are assumed to be 9.38 per cent of final demand. Losses will decrease as more 500 kV transmission is introduced into the system.

The small utilities in the Province will add small amounts of new generation and their fuel is assumed to be mostly hydraulic. Industrial generation is about 40 per cent hydraulic with the rest being mostly gas-fired. Much of the fossil fuel generation is cogeneration of steam and electricity. Cogeneration capacity is expected to more than double by the year 2000. Industrial generation and small utilities currently supply about 6 per cent of Ontario's electricity demand. Additional generation is expected from small-scale hydro and energy from waste.

The projections of primary fuel requirement for Ontario Hydro generation are based on the existing system expansion program. Hydraulic capacity is expected to increase by about 650 MW of peaking capacity by the end of the century. Nuclear output is based on a load factor consistent with both the system load pattern and the technical and economic operating characteristics of nuclear plants. Oil and gas used to generate electricity by Ontario Hydro is not significant and is expected to decrease to almost zero.

APPENDIX ONE: TOTAL ENERGY DEMAND BY SECTOR AND FUEL FOR 1980, 1985, 1990, 1995 AND 2000

TABLE A.1

TOTAL ONTARIO ENERGY DEMAND BY SECTOR AND FUEL

1980

(Petajoules)

	Coal	Oil	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential		148	209	118			10	485
Commercial		46	140	99				285
Industrial	209	153	356	134			47	899
Transportation		625		1				626
Total Secondary	209	972	705	352			57	2,295
Petrochemical		129						129
Non-Energy		66						66
Energy Industry		121	28	36				185
Electrical Gen.	282	3	16		423	400		1,124
Total	491	1,291	749	388	423	400	57	3,799
Less Electricity				388				388
Total Primary	491	1,291	749	-	423	400	57	3,411

Source: Ontario Ministry of Energy

TABLE A.2

TOTAL ONTARIO ENERGY DEMAND BY SECTOR AND FUEL

1985

(Petajoules)

	Coal	Oil	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential		86	242	133			13	474
Commercial		36	148	106				290
Industrial	207	114	317	137			60	835
Transportation	—	546	—	1	—	—	10	557
Total Secondary	207	782	707	377			83	2,156
Petrochemical		102						102
Non-Energy		59						59
Energy Industry		95	29	44				168
Electrical Gen.	232	3	10	—	420	557	2	1,224
Total	439	1,041	746	421	420	557	85	3,709
Less Electricity	—	—	—	421	—	—	—	421
Total Primary	439	1,041	746	-	420	557	85	3,288

Source: Ontario Ministry of Energy

TABLE A.3

TOTAL ONTARIO ENERGY DEMAND BY SECTOR AND FUEL

1990

(Petajoules)

	Coal	Oil	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential		49	258	145			14	466
Commercial		26	155	116				297
Industrial	250	130	409	154			66	1,009
Transportation		537		1			29	567
Total Secondary	250	742	822	416			109	2,339
Petrochemical		113						113
Non-Energy		69						69
Energy Industry		94	29	48				171
Electrical Gen.	151	3	10		420	765	3	1,352
Total	401	1,021	861	464	420	765	112	4,044
Less Electricity				464				464
Total Primary	401	1,021	861	-	420	765	112	3,580

Source: Ontario Ministry of Energy

TABLE A.4

TOTAL ONTARIO ENERGY DEMAND BY SECTOR AND FUEL

1995

(Petajoules)

	Coal	Oil	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential		36	254	156			15	461
Commercial		21	167	134			2	324
Industrial	277	136	433	177			71	1,094
Transportation	—	552	—	2	—	—	50	604
Total Secondary	277	745	854	469			138	2,483
Petrochemical		124						124
Non-Energy		71						71
Energy Industry		96	30	53				179
Electrical Gen.	184	3	15	—	446	860	4	1,512
Total	461	1,039	899	522	446	860	142	4,369
Less Electricity	—	—	—	522	—	—	—	522
Total Primary	461	1,039	899	-	446	860	142	3,847

Source: Ontario Ministry of Energy

TABLE A.5

TOTAL ONTARIO ENERGY DEMAND BY SECTOR AND FUEL

2000

(Petajoules)

	Coal	Oil	Natural Gas	Electricity	Hydro	Nuclear	Other	Total
Residential		23	248	166			16	453
Commercial		17	174	154			3	348
Industrial	310	145	490	209			81	1,235
Transportation		574		3			58	635
Total Secondary	310	759	912	532			158	2,671
Petrochemical		137						137
Non-Energy		73						73
Energy Industry		100	31	59				190
Electrical Gen.	234	1	20		454	996	5	1,710
Total	544	1,070	963	591	454	996	163	4,781
Less Electricity				591				591
Total Primary	544	1,070	963	-	454	996	163	4,190

Source: Ontario Ministry of Energy

POOR

QUALITY

ORIGINAL